Selecting the Right Closure Cap Option for Your Surface Impoundment or CCR Landfill

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ABSTRACT

Traditional final cover and capping designs for coal combustion residual (CCR) surface impoundments and landfills have included compacted soil liner, geomembrane liner, a drainage layer, and a vegetative soil cover. These traditional capping options involve large volumes of soil that many coal-fired plants may not have available.

Alternative capping options have recently emerged in the industry, such as exposed geomembrane liners or synthetic turf/geomembrane liner systems. Some of these alternative capping options have many advantages over their traditional counterparts. These advantages include faster installation times, minimal soils needed, improved storm water quality, and reduced maintenance and post-closure costs. For surface impoundments, using an alternative capping design can also greatly reduce the amount of disturbance of the existing CCR material within the impoundment.

This paper examines the advantages and disadvantages of these emerging alternative capping options.

BACKGROUND

Municipal solid waste (MSW) landfills have had Federal closure requirements since 1992 with the enactment of 40 CFR Part 258 Subtitle D. According to these regulations, the final cover system must be designed and constructed to:

1. Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1×10^{-5} cm/sec, whichever is less.

2. Minimize infiltration through the closed MSW landfill by the use of an infiltration layer that contains a minimum 18 inches of earthen material.

3. Minimize erosion of the final cover by using an erosion layer that contains a minimum 6 inches of earthen material that is capable of sustaining native plant growth.

Although the above rules do not specifically mention the use of a geomembrane liner in a final cover system, the first requirement states *"permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1×10^{-5} cm/sec, whichever is less."* Essentially this means if you have a geomembrane in the base liner system, you will need a geomembrane liner in the final cover system.

Prior to the 1992 federal regulations, many state regulations had final cover design requirements similar to the Subtitle D requirements. For landfills in these states, capping designs with geomembrane liners were common, although the industry was still on the "learning curve."

CCR REGULATIONS

On April 17, 2015 the U.S. Environmental Protection Agency (USEPA) published its final rule governing disposal of CCR produced by electric utilities. The rule appears at *80 Federal Register 21302* and went into effect on October 19, 2015.

The rule classifies CCR from electric utilities as a new category of solid waste and regulates CCR disposal under the Resource Conservation and Recovery Act (RCRA) Subtitle D (solid waste). The rule requires facilities meet detailed location, design, operation, closure, and post-closure care requirements, or the facility will be considered an "open dump" subject to citizens' suit enforcement under RCRA. All CCR units must have written closure and post-closure care plans and keep those plans current. Two basic forms of closure are allowed: (1) closure by removal of CCR (clean closure), or (2) closure leaving CCR in place.

If the unit is closed leaving CCR in place, a final cover must be designed and installed that is no more permeable than the liner under the unit. A minimum of 18 inches of soil compacted to a permeability no greater than $1x10^{-5}$ cm/sec is required for an infiltration layer, covered by a vegetative soil layer at least 6 inches thick. The rules provide for alternative cover designs if certain demonstrations can be made.

Final covers must be designed to accommodate anticipated settlement, and if the impoundment contains free liquids, they must be removed or solidified before the final cover is installed. There also may be a need to stabilize the CCR material so that it can support the final cap.

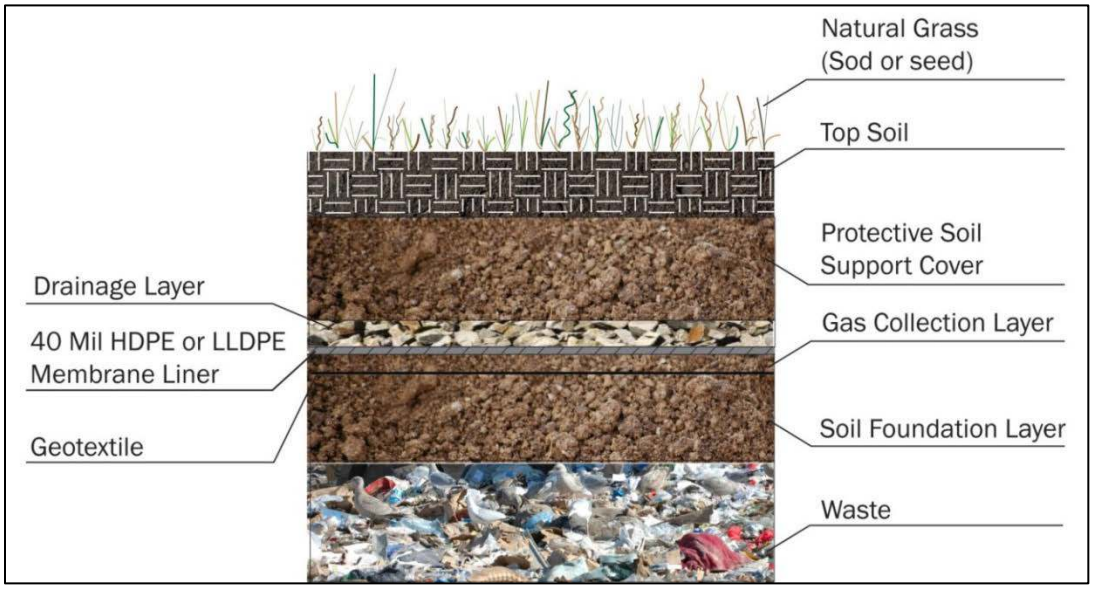
If CCR remains in the unit following closure, the unit is subject to post-closure care for 30 years, including maintenance of and repairs to final covers and other unit components, and semiannual detection and/or assessment monitoring of groundwater.

TRADITIONAL CLOSURE DESIGNS

As a result of the Subtitle D rules and the development of geosynthetics, the traditional landfill final cover system over the past 15+ years consisted of the following components from top to bottom:

- 24-36-inch thick vegetative/erosion soil cover
- Geocomposite drainage layer
- 40-mil HDPE/LLDPE geomembrane liner
- 18-inch thick infiltration soil layer

A detail of a traditional landfill cap used for MSW landfills is below:



Landfill closure projects have unique challenges. Steep slopes, storm water controls, settlement, and stability issues are a few. Geocomposite drainage layer failures have contributed to several veneer slope stability failures.

Another challenge with traditional capping systems is that it takes a large volume of soil to build the cap.

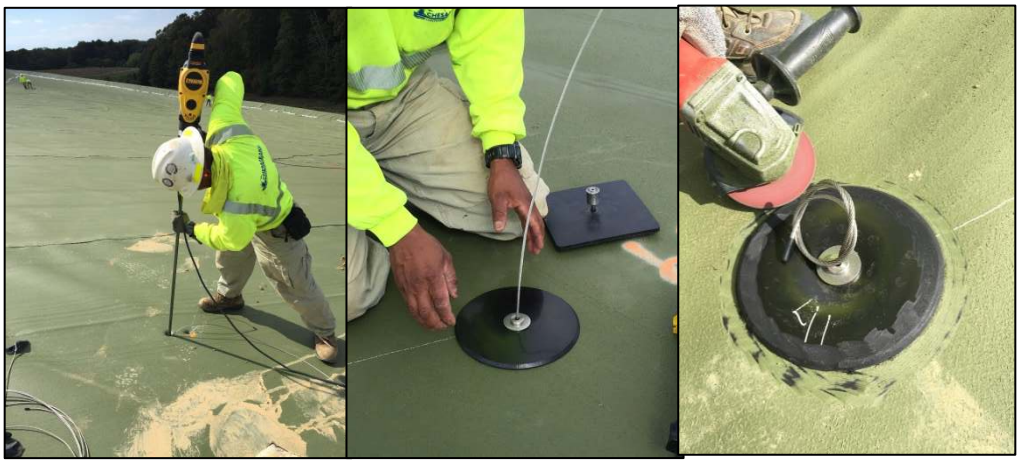
ALTERNATIVE CAPPING DESIGNS

Alternative final cover designs have been used across the country for years. Here are four alternative cover designs. Not all of them include a vegetative soil layer or infiltration barrier layer.

<u>Exposed Geomembrane Liner</u>
MSW professionals have been using exposed geomembrane liner covers to temporarily and permanently close waste disposal units for decades. Early attempts to use exposed geomembrane liners resulted in designs with numerous anchor trenches to prevent wind uplift. Also, some exposed liner designs included sand bags or other ballast placed directly on the liner to prevent wind uplift.

Common problems with exposed geomembrane liners include excess wrinkles and large volumes of surface water runoff.

New anchoring systems have been incorporated into the exposed capping system as shown below. These systems minimize wrinkles, eliminate the need for numerous anchor trenches, and make installation easier.



Benefits for the exposed geomembrane capping system include:

- No cover soil
- No soil veneer stability issues
- Reduced O&M costs
- Reduced capital costs
- Additional airspace
- Quick installation
- Visual geomembrane inspection

ClosureTurf

According to ClosureTurf's website,

> *"ClosureTurf® is a patented, three component system comprised of a structured geomembrane, an engineered turf, and a specialized sand infill."*

There are two separate geosynthetics that make up the ClosureTurf product. The lower geosynthetic is a 50-mil linear low-density polyethylene (LLDPE) geomembrane liner manufactured by Agru America. The upper component is a geotextile with synthetic grass-like fibers. Following the installation of these components, a 1/2-inch sand infill layer is applied. The sand helps reduce the effects of wind uplift and also protects the geotextile from ultraviolet (UV) damage.

A detail of the ClosureTurf detail next to a traditional cap detail is shown below.

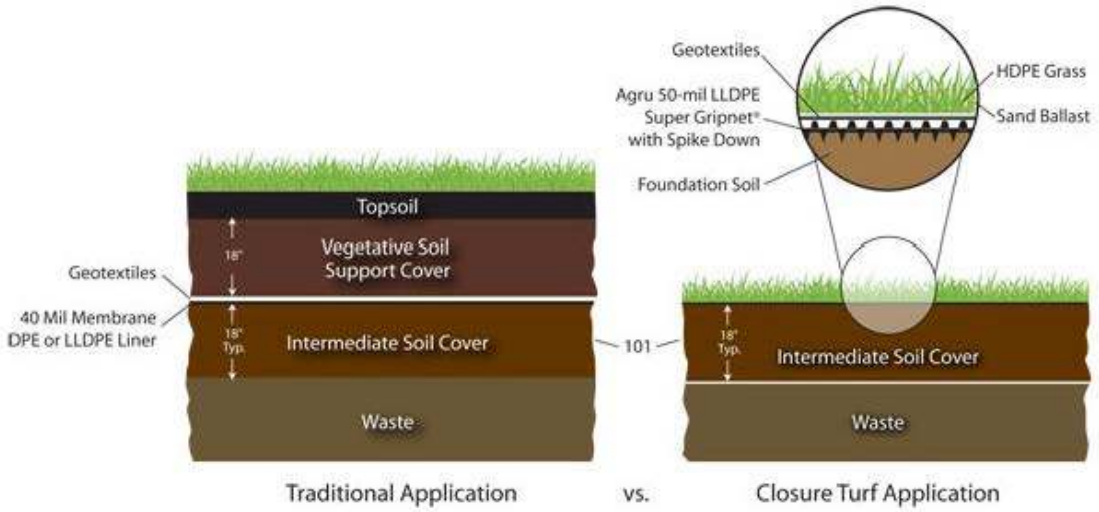


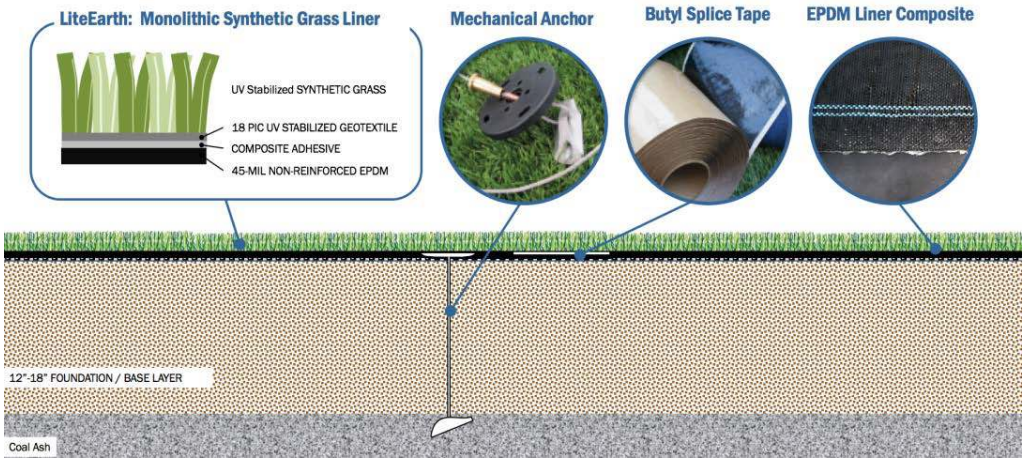
Figure 2b – Installation of Closure Turf

ClosureTurf has been tested in the laboratory for wind uplift potential and for the hydraulic properties of the drainage zone (area in between the geotextile backing the geomembrane liner) and sand infill.

In some states regulators view this alternative capping system as an "intermediate cover," and other states view it as a permanent final cover. Most states have been receptive but are requiring a "testing and inspection program" because this is a new product. ClosureTurf, which is manufactured by WaterShed Geo, has been installed at dozens of landfills (MSW and industrial) across the United States. The first application was in 2009 at the Lasalle-Grant Landfill in Louisiana.

<u>LiteEarth</u>

According to information provided but LiteEarth, their capping system consists of an EPDM geomembrane liner with a synthetic grass on woven backing. A detail is shown below. The LiteEarth material is seamed with tape and glue and anchored to the cover system with mechanical anchors.



LiteEarth's primary manufacturing location is in Calhoun, Georgia. LiteEarth holds the patent for the material, and GSE has recently obtained the rights for marketing and sales of the product.

To date there has been a limited amount of LiteEarth installed as a capping system. However the product has been used extensively in sports fields for a number of years.

Wind Defender

Wind Defender is a special reinforced geotextile windscreen made of knitted green UV stabilized high-density polyethene (HDPE) filament. The reinforced geotextile is installed on top of an exposed geomembrane liner. The windscreen is designed to resist uplift forces caused by wind. So instead of using multiple traditional anchor trenches or mechanical anchors, the windscreen is designed to secure the exposed geomembrane.

ADVANTAGES AND DISADVANTAGES

You should evaluate the advantages and disadvantages for your specific application. For any project, the closure options must be determined on a case by case basis before selecting the right cap design for your site. Here are some factors to consider in your evaluation.

Advantages of an Alternative Closure Design	**Disadvantages of Alternative Closure Design**
No soil cover, no veneer failure potential	Relatively new product; how long will it last?
Reduced erosion and improved storm water quality	May need to modify storm water controls if not sized to handle large runoff volumes
Post-closure care – reduced costs	Access on the cap with equipment
Less cap maintenance, no mowing or repairing erosion rills – reduced costs	Uncertainty how financial assurance will be addressed
Less soil, less construction time	State acceptance
Easier reclamation access	
1/5 the carbon footprint[1]	

[1] Source: Koerner, R. "Traditional vs Exposed Landfill Covers-Cost and Sustainability Perspectives" Geosynthetic Magazine, Oct. 2012

Cost Variables

The primary variable to consider when evaluating the cost-effectiveness of an alternative capping option is the availability of soil. The volume of soil needed to construct a 50-acre traditional cap can be as much as 400,000 cubic yards (cy). Assuming on-site soil costs vary between $4 and $15/cy and off-site between $10 and $25/cy, the cost for the soil component alone can range from $1.6 million to $10 million for a 50-acre cap.

The second variable to consider is the facility's existing storm water management system. The site's storm water channels and sediment basins may be undersized to handle the storm water runoff from the alternative capping options discussed here.

For example, SCS Engineers conducted the hydrologic and hydraulic evaluation for the existing storm water channels and sediment basin for a landfill in the Southeastern United States. The peak storm water runoff from a 25-year/24-hour storm for the 72-acre landfill with the traditional final cover system was approximately 210 cubic feet per second (cfs). If the entire landfill was closed with one of the alternative covers discussed in the paper, the peak discharge was estimated to be over 350 cfs.

CONCLUSION

While alternative capping systems are becoming more prevalent, it is important to work with your regulator because state regulatory agencies are not all accepting the same things at the same pace. Some states have fully approved synthetic covers for final closure, while others have only approved them for intermediate cover with the intent of approving it for final cover after an evaluation period. Work with your regulator and evaluate the site-specific advantages and disadvantages to choose the best cover for your site.